SCATTERABLE ANTIPERSONNEL MINE TEST
DATA SUMMARY

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Modern Army Selected Systems Test, Evaluation
and Review
Fort Hood, Texas

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13. ABSTRACT

The Scatterable Antipersonnel Mines Test was conducted at Fort Hood, Texas, from 24 September to 5 October 1973. The test was conducted to collect data on the detectability of tripwires. Resulting data tables were used in a computer simulation on tripwire effectiveness. The test provided information on some effective tripwire countermeasures.

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Detectability						
Tactile Detection						

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SUBJECT: Detectability of Tripwires, Antipersonnel Mine Test, FM 230

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1. References:

    a. Outline Test Plan, Scatterable Antipersonnel Mine Test, 27 June
1973.

    b. Detailed Plan of Test, MASSTER Test FM 230, Scatterable Anti-
personnel Mine, 24 September 1973.

2. Authority: Department of the Army Five Year Test Program, 25 July
1973.

3. Objectives: Test objectives as contained in the outline plan of
test were modified at a meeting between representatives from the Office
of the Project Manager for Selected Ammunition and Headquarters, MASSTER
on 9 and 10 August 1973. As modified, the objectives were to provide
data on the detectability of tripwires, target sensing capability
of tripwires, and troop movement speeds; and to provide subjective
observations on the performance of the tripwires. These new test
objectives were approved at the Detailed In-Process-Review on 23 August
1973.

4. Conduct of Test: This test was conducted generally in accordance
with reference 1b. However, there were changes made to the test plan.

    a. The mine lane densities were reduced from 10 mines to 5 mines
for the low density mine courses and from 20 mines to 15 mines for
the high density courses. This change was concurred in by represen-
tatives of the test proponent, the Army Materiel Command (the Project
Manager for Selected Ammunition).

    b. The unexpected high frequency of broken tripwires and the
lack of spare wires resulted in the use of 8-pound monofilament fishline
as a substitute. This line was similar in strength and size to the
standard tripwire; however, detection of the substitute may have been

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easier due to a color difference and the adhesion of visible moisture.
The substitution was necessary on the last day of the test only,
resulting in 150 tripwire (fishline) exposures out of a total of
18,810 exposures in the test (approximately 1 percent).

5. Results of Test: In addition to providing the data required
by the Army Materiel Command, the test provided useful information to
the soldier and commander who might be confronted with tripwire mines.
The inclosed data summary contains the semireduced data required to
satisfy the test objectives as well as other points of value.

FOR THE COMMANDER:

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JOSEPH L. CONSOLO
MAJ, AGC
Adjutant

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DATA SUMMARY

1. Description.

a. Background.

(1) Authority. This test was authorized by letter, DAFD, Head-
quarters, Department of the Army, subject: Department of the Army Five
Year Test Program (FY 1974 - 1978), dated 25 July 1973.

(2) The Army Materiel Command's (AMC) Project Manager for Selected
Ammunition requested that MASSTER conduct a test to collect information
concerning the detectability of tripwires. This information will be used
in studies of design characteristics for scatterable antipersonnel mines.
AMC's project manager is considering three basic mine concepts (tripwire,
seismic, and acoustic) as candidates for the role of scatterable anti-
personnel mines.

b. General characteristics.

(1) Scatterable antipersonnel mines are characterized by different
modes of delivery, mandatory self-destruction, rapid emplacement in
inaccessible areas, handling devices, and self-neutralization features.
They can be used to close lanes and gaps, increase the depth of a defen-
sive position in the face of an enemy advance, remine breached areas, and
interdict enemy lines of communication. (Conceptually, the pull required
to activate the actual tripwire mine will be four-tenths of a pound.
(181.2 grams) of force.)

(2) Each dummy tripwire mine used during the test consisted of an
M1 pressure release firing device, a two- by four-inch solid steel cyl-
inder, and a 10-meter-long black cord tripwire. The cylinder was placed
vertically on the release plate of the M1 firing device. A primer cap
was positioned so that a firing pin struck it when the release plate was
moved. The release plate moved when the tripwire attached to the top
of the cylinder was subjected to a pull force of five-tenths of a pound
(227 grams). The resulting explosion and smoke ignition simulated the
activation of a mine.

c. Purpose. The purpose of the test was to determine the detect-
ability of tripwires.

d. Scope. Tripwire antipersonnel mines were tested to determine
the probability of detecting tripwires, the probability of detonating

a mine, and the relative delay to the advance of dismounted infantrymen caused by the presence of tripwire mines. The test was conducted in two areas simultaneously, one wooded and one grassy, with varied densities of mines. Two subtests were used:

(1) Subtest I, Baseline Test (day 1). This test was conducted to determine the average time for squads to traverse each of the controlled lanes. No tripwires were present during this subtest. Times from this subtest were used as a basis for calculation of the relative time delays caused by the presence of tripwire mines.

(2) Subtest II, Controlled Conditions Test (days 2 through 6). This test was conducted to determine the number of tripwires that were detected, the number of tripwires that were tripped and caused activation of a mine simulator, the number of tripwires that were not detected, and time required to traverse the minefields.

2. Objectives. Test objectives are stated below:

a. Objective 1. Determine the probability of a soldier in a squad detecting tripwires in a minefield across his path.

(1) Subobjective 1.1. Determine the proportion of soldiers in a squad that detect one or more tripwires in a minefield across their path (and the number of tripwires detected by each), under each combination of terrain, mine density, soldier velocity, and soldier action tested.

(2) Subobjective 1.2. Determine the average number of tripwires detected by soldiers of a squad in minefields across their path under each combination of terrain, mine density, soldier velocity, and soldier action tested.

b. Objective 2. Determine the probability of a soldier in a squad activating tripwire mines in a minefield across his path.

(1) Subobjective 2.1. Determine the proportion of soldiers in a squad that activate one or more simulated tripwire mines in a minefield across their path under each combination of terrain, mine density, soldier velocity, and soldier action tested.

(2) Subobjective 2.2. Determine the average number of simulated mines activated by soldiers of a squad in minefields across their path, under each combination of terrain, mine density, soldier velocity, and soldier action tested.

c. Objective 3. Investigate the time delay results of a tripwire minefield.

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(1)   Subobjective 3.1.   Determine the average amount of time taken by a squad to traverse a premeasured lane under each combination of terrain, mine density, soldier velocity, and soldier action tested.

(2)   Subobjective 3.2.   Determine the difference in time taken by a squad to traverse a premeasured lane under each combination of terrain, mine density, soldier velocity, and soldier action tested.

3.   Methodology.

a.   Conduct.   The test was conducted on 7 test days during the period 24 September to 5 October 1973.   Personnel from the 1st Battalion, 8th Cavalry, 1st Cavalry Division were used as test personnel.   They were organized into eight squads of 10 men each, including the squad leader. Nine members of the squad traversed the various test control lanes in line formations under the control of the squad leader.   All squad members, except the squad leader, were graded on the aspects being scored during each test run.   (A test run is defined as a squad going through a partic- ular terrain course under one condition of mine density, soldier speed, and soldier action.)   The squad members moved through well defined con- trol lanes which were 9 meters wide and 100 meters long.   While moving through the lanes at speeds controlled by their squad leader, they fired their weapons when required to (predetermined by the run being conducted), and searched for tripwires.   When a tripwire was detected, the soldier identified it by placing a white marker within 9 inches of the tripwire, avoided the tripwire, and proceeded through the lane at the prescribed speed.   ersonnel from Headquarters, MASSTER served as controllers, data collectors, and data reducers.   Data reduction was performed by using the scheme in figure I.   Data collectors followed each squad member (in a tripwire-free control area beside each lane) and recorded the required data.   After the squad completed traversing the lanes on a run, the data collectors verified that a tripwire did, in fact, exist in the vicinity of the white markers which were placed in the lane during the run.

b.   Data collected.

(1)   Subtest I, Baseline Test.

(a)   Squad identification.

(b)   Terrain course number.

(c)   Soldier speeds.

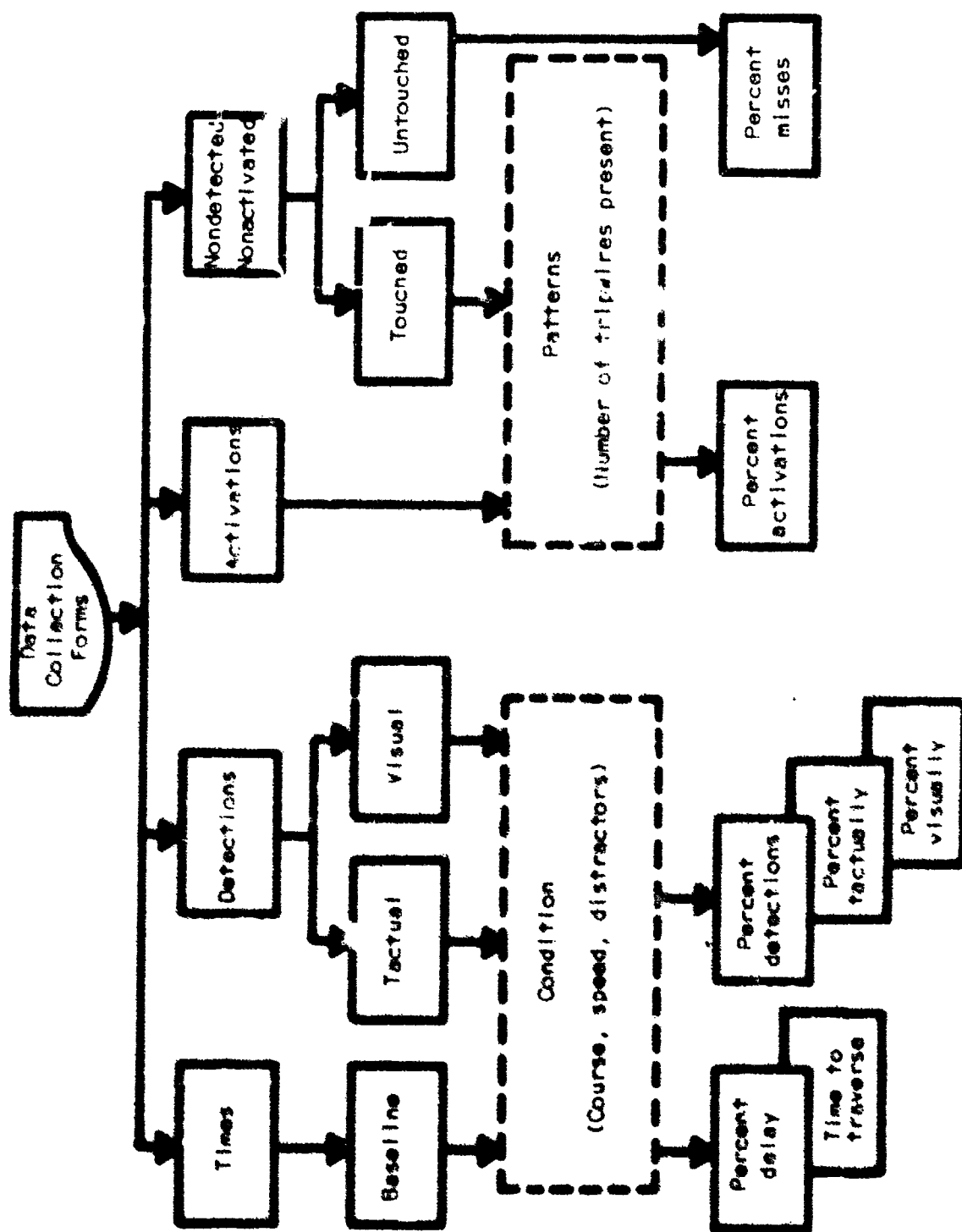(d)   Start times.

(e)   Finish times.

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Figure 1. Data reduction scheme.

(2) Subtest II, Controlled Conditions Test.

(a) Squad identification.

(b) Terrain course number.

(c) Soldier speeds.

(d) Start times.

(e) Finish times.

(f) Number of tripwires detected (visual and tactile).

<u>1</u> Visual detections.

<u>2</u> Tactile detections.

<u>3</u> Total detections.

(g) Number of mines detonated.

(h) Number of tripwires not detected and number of associated mines not detonated.

c. Principle test variables.

(1) Minefield densities. During subtest II, the number of mines positioned within each individual control lane were described as low density or high density. A schematic for the layout for each control lane for each day's run was prepared by representatives from AMC's Office of the Project Manager for Selected Ammunition and given to controllers in a format similar to that shown in figure 2.

(a) Low density. Ten mines per lane were installed on day 3; on all other days, there were five mines with tripwires and five mines without tripwires in each lane. The mines without tripwires were used solely as a deception factor.

(b) High density. Twenty mines per lane were installed on day 3; on all other days, there were 15 mines with tripwires and 5 mines without tripwires in each lane. The mines without tripwires were used solely as a deception factor.

(2) Terrain layout. The test area was divided into four courses. The course number uniquely describes the type terrain and mine density. The course numbers are discussed below:

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Subject Name:_____ Rank:_____ Squad Number_____

Lane Number:_____ Speed Condition:_____ Traverse Time:____

Distraction Condition:_____ Terrain:_____
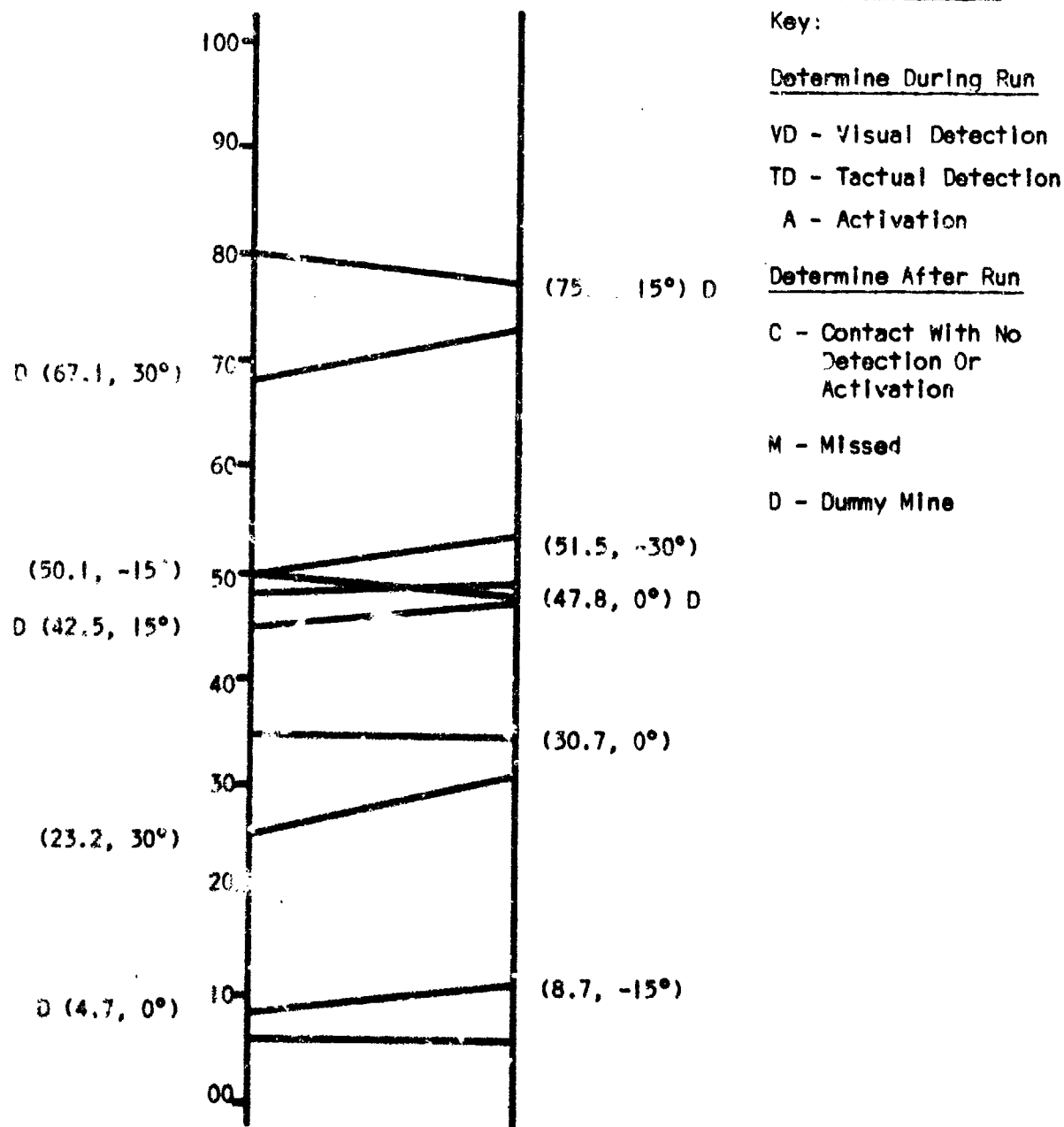
Observer's Name:_____ Date:_____

Figure 2. Lane schematic.

(a) Course I (fig 3) was in a grassy area (height of grass was approximately 2 inches, and stick weeds approximately 12 inches high were interspersed throughout the area), and it contained nine control lanes. Each lane was 100 meters in length. The lanes contained a low density of mines. (There were 10 mines per lane on day 3; on all other days, there were 5 mines with tripwires and 5 mines without tripwires in each lane. The mines without tripwires were used solely as a deception factor.)
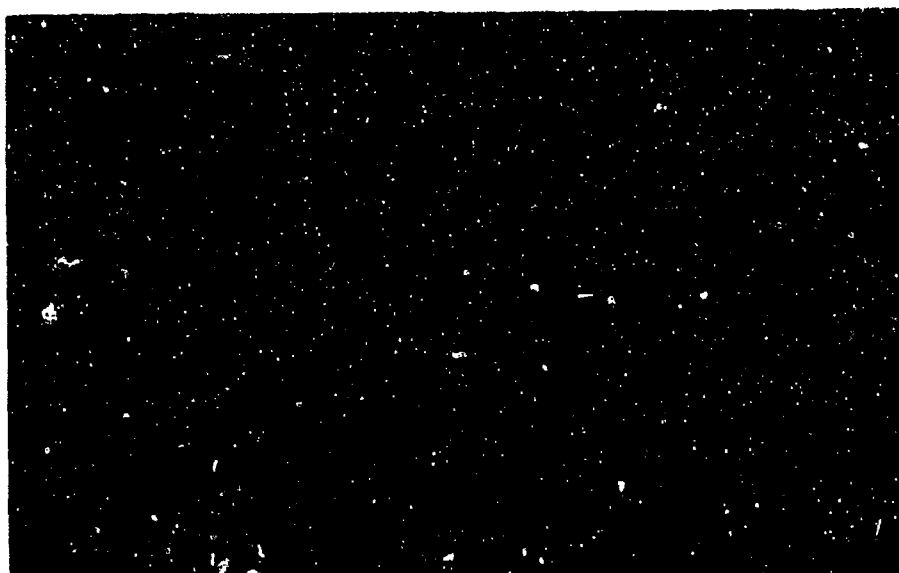

Figure 3. Course I.

(b) Course II (fig 4) was in a grassy area (height of grass was approximately 2 inches, and stick weeds approximately 12 inches high were interspersed throughout the area), and it contained nine control lanes. Each lane was 100 meters long. The lanes contained a high density of mines. (There were 20 mines per lane on day 3; on all other days, there were 15 mines with tripwires and 5 mines without tripwires in each lane. The mines without tripwires were used solely as a deception factor.)

(c) Course III (fig 5) was in a lightly wooded area that had grass approximately 24 inches high. The area contained nine control lanes, each of which was 100 meters long. The lanes contained a low density of mines.
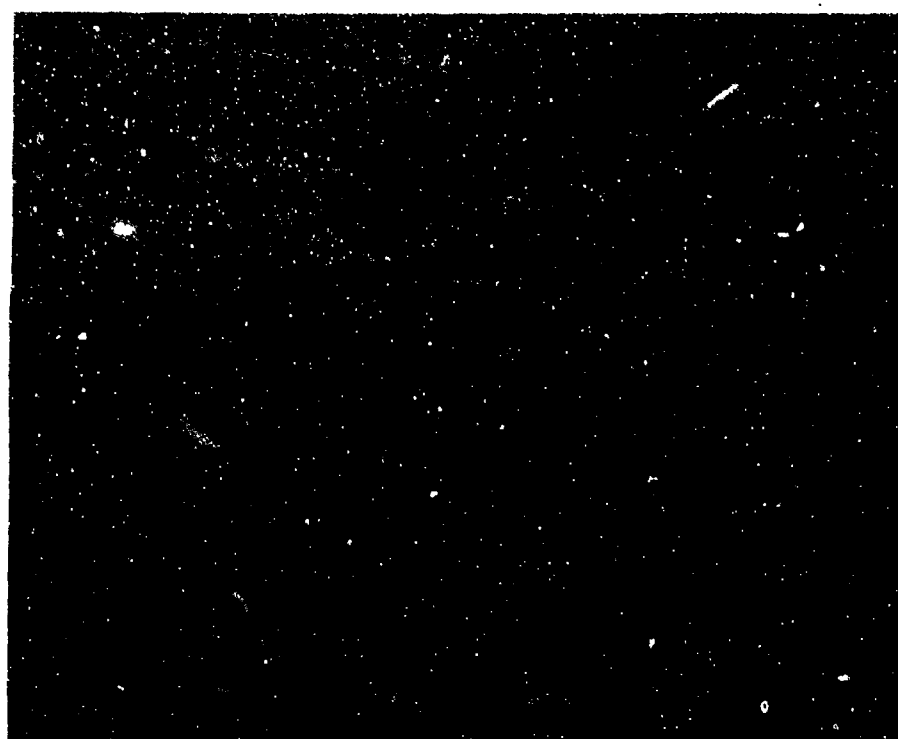
Figure 4. Course II.

Figure 5. Course III.

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(d) Course IV (fig 6) was in a moderately wooded area that had little grass. Clumps of deadfall were scattered along the lanes. The area contained nine control lanes, each of which was 100 meters long. Two of the lanes, lanes 3 and 4, encompassed a dirt road. The lanes contained a high density of mines.
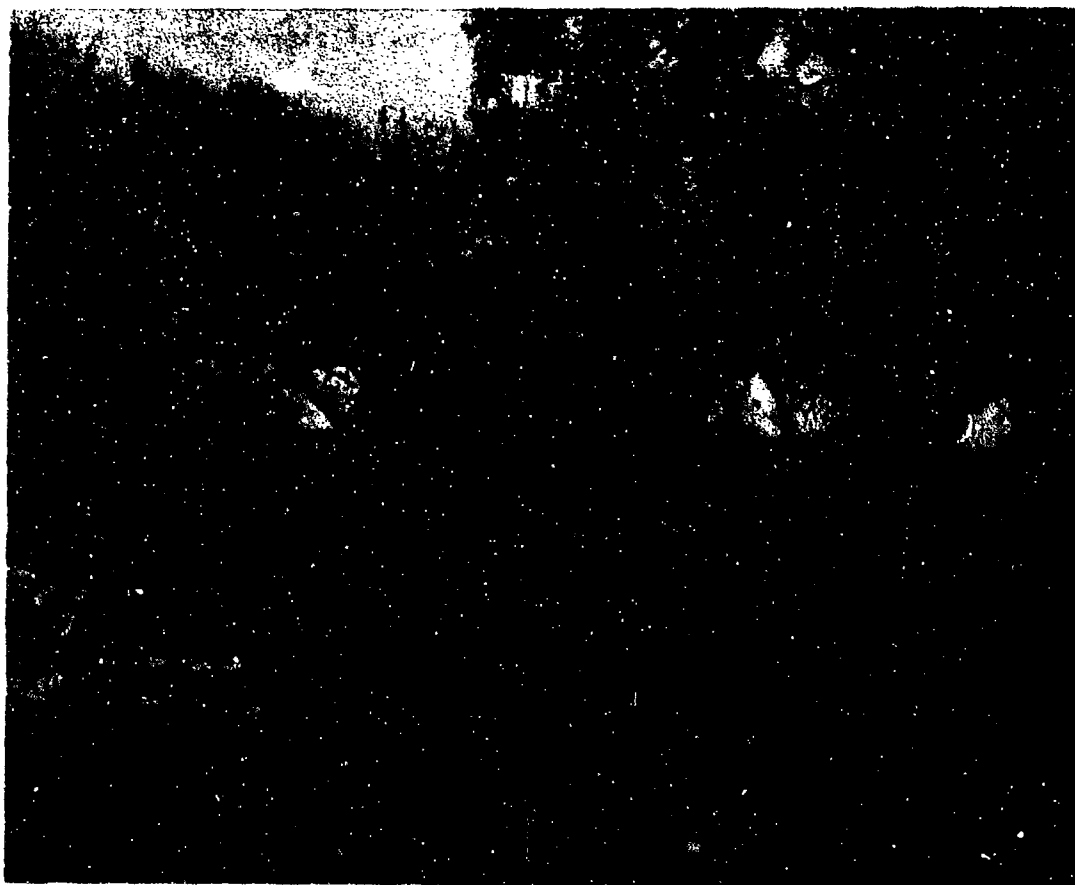

Figure 6. Course IV.

(3) Condition. The four speeds at which soldiers traversed the test lanes and the firing or nonfiring action of the soldier were varied during the test. The combinations defined and used during the test were as follow:

(a) Nonfiring actions.

1 Very fast speed. A run, approximately 180 steps per minute.

$\underline{2}$ Fast speed. Approximately 120 steps per minute.

$\underline{3}$ Slow speed. Approximately 80 steps per minute.

$\underline{4}$ Crawl. Moving slowly with the body close to the ground.

(b) Firing actions.

$\underline{1}$ Fast speed firing. Firing two magazines of blank ammunition per man while moving 120 steps per minute.

$\underline{2}$ Slow speed firing. Firing two magazines of blank ammunition per man while moving 80 steps per minute.

(4) Distractors. Two types of distractors were used during the test. One was mines which did not contain tripwires. This distractor was used to discourage the use of sighting the mine itself as a key for initiation of a more thorough search for a tripwire. The second distractor used was that of requiring soldiers, who were traversing the lanes, o point their weapons and to fire two magazines of blank ammunition. A round was fired approximately every second step as the soldiers moved through at a fast speed.

4. Findings.

a. Objective I was to determine the probability of a soldier in a squad detecting tripwires in a minefield across his path. Detailed data supporting the findings for this objective are found in the figures. Tactual detections with the simulator were likely more successful than would have been experienced with an actual mine because of the difference in tripwire sensitivity (four-tenths for actual mines versus five-tenths for the simulators). A summary of findings by subobjective are shown below:

(1) Subobjective 1.1.

(a) Figure 7 contains a complete listing of each squad's frequency of detection. Every squad had at least one run in which no tripwires were detected. There were 21 runs (11 percent) in which no detections were made. There were 27 runs in which every squad member detected at least one tripwire. The most common occurrence was that six squad members detected at least one tripwire; this occurred 29 times.

(b) Figure 8 contains a listing of the proportion of soldiers detecting one or more tripwires. Under all combinations tested (terrain, mine density, soldier speed, and soldier action) the proportion of soldiers detecting one or more tripwires ranged from a high of 100 percent to a

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low of 10 percent. The high occurred once when the troops were moving slowly through a high density minefield in a grassy area. The low probability occurred three times. Two times the troops were moving very fast, and one time they were moving fast and firing their weapons.

(2) Subobjective 1.2.

(a) Figure 9 contains a listing for each squad. In the high density course (15 tripwires per lane) the maximum number of tripwires detected by an individual during a run was 15. This occurred 2 times out of 1,728 times. In the low density course (5 tripwires per lane), the maximum number of tripwires detected by an individual during a run was five. This occurred 26 times out of 1,728 times.

(b) The average number of tripwires detected by an individual who made detections ranged from nine while crawling through a high density minefield in a grassy area to one while he was moving very fast through the same area.

(c) Of the tripwire detections, 53 percent were made visually, and 47 percent were made tactually. Figures 10 through 19 give a detailed breakout by squad, terrain course, soldier speed, and soldier actions.

b. Objective 2 was to determine the probability of a soldier in a squad activating tripwire mines in a minefield across his path. The findings for this objective are shown by subobjective.

(1) Subobjective 2.1.

(a) There were no runs in which no tripwire mines were activated. Figures 10 through 19 have a complete listing of squad activations.

(b) Under all combinations tested (terrain, mine density, soldier speed, and soldier action), the proportion of soldiers that activated one or more mines ranged from a high of 100 percent to a low of 64 percent. The high percentage occurred twice when the troops were moving fast through a high density minefield in the grassy area and again when they were moving fast and firing their weapons in the low density minefield in the wooded area. The low probability occurred once when the troops were crawling through a low density minefield in the grassy area (fig 19).

(2) Subobjective 2.2.

(a) The maximum number of activations by an individual during a run was 15 or 100 percent of the mines present. Figure 11 contains information on all squads.

Subobjective: 1.1 Proportion of soldiers in a squad that detected one or more tripwires in a minefield across their path (and the number of tripwires detected by each).

Total number of individuals making at least one detection per run	Squad							
	A	B	C	D	E	F	G	H
0	1	3	4	2	2	4	4	1
1	5	2	0	4	4	1	5	5
2	3	0	0	0	3	3	3	2
3	1	3	0	1	1	4	2	1
4	2	2	0	2	2	1	0	3
5	2	0	1	3	3	0	3	1
6	2	3	8	5	3	4	2	2
7	2	5	5	2	2	4	1	3
8	2	2	2	1	1	1	1	3
9	4	4	4	4	3	2	3	3

Figure 7. Squad frequency of detection.

Subobjectives: 1.1 Proportion of soldiers in a squad who detected one or more tripwires in their lanes under the following conditions.

1.2 Average number of tripwires detected by soldiers in a minefield across their path under each of the following conditions.

Course	Speed	Number who detected one or more tripwires	Proportion (subobj 1.1)	Total number of tripwires detected	Average number of tripwires detected by each detector	Average number of tripwires detected by each squad member (subobj 1.2)
I Grassy Low Density	Very fast	9	0.13	11	1.1	0.14
	Fast	13	0.18	39	3.0	0.54
	Slow	34	0.47	96	2.8	1.33
	Crawl	66	0.92	221	3.3	3.06
	Fast firing	46	0.64	97	2.1	1.34
	Slow firing	54	0.75	135	2.5	1.87
II Grassy High Density	Very fast	7	0.10	8	1.1	0.11
	Fast	17	0.24	75	4.4	1.04
	Slow	72	1.00	444	6.1	6.16
	Crawl	70	0.97	646	9.2	8.97
	Fast firing	40	0.56	191	4.7	2.65
	Slow firing	47	0.65	243	5.1	3.37
III Wooded Low Density	Very fast	7	0.10	11	1.5	0.15
	Fast	18	0.25	28	1.5	0.38
	Slow	35	0.49	70	2.0	0.97
	Crawl	62	0.86	174	2.8	2.41
	Fast firing	7	0.10	10	1.4	0.14
	Slow firing	15	0.21	21	1.4	0.29

Figure 8. Tripwire detection summary.

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Course	Speed	Number who detected one or more tripwires	Proportion (subobj 1.1)	Total number of tripwires detected	Average number of tripwires detected by each detector	Average number of tripwires detected by each squad member (subobj 1.2)
IV Wooded High Density	Very fast	14	0.19	48	3.4	0.66
	Fast	23	0.32	126	5.4	1.75
	Slow	42	0.58	162	3.8	2.25
	Crawl	70	0.97	540	7.7	7.50
	Fast firing	15	0.21	65	4.3	0.90
	Slow firing	18	0.25	66	3.6	0.91

NOTE: Number of soldiers is 72 for all conditions.

Figure 8 (cont). Tripwire detection summary.

Subobjective: 1.2 Average number of tripwires detected by soldiers, of a squad, in a minefield across their path.

Number detected	Squad							
	A	B	C	D	E	F	G	H
1	4	1	1	1	4	1	1	3
2	0	2	2	4	1	4	1	2
3	2	4	2	2	1	1	2	2
4	2	1	4	1	3	3	4	4
5	5	4	1	5	4	2	3	2
6	0	1	0	0	2	1	2	1
7	2	2	3	2	1	1	0	2
8	1	1	2	2	3	2	2	2
9	1	0	1	0	0	1	1	1
10	1	0	0	1	0	1	0	1
11	1	2	1	1	1	0	3	0
12	1	1	3	0	2	0	0	0
13	1	0	-	0	-	1	0	1
14	2	2	-	2	-	1	1	2
15	-	-	-	1	-	1	-	-

Figure 9. Maximum number of tripwires detected during a run by a squad member who made a detection.

Squads	Visual	Tactile
A	231	223
B	222	222
C	246	207
D	272	200
E	199	184
F	204	207
G	187	200
H	293	217
TOTAL	1,854	1,669
Percent of detections	53	47

Figure 10.   Summary of total detections made.

Figure 11. Accumulated squad data for squad A.

Course	Speed	Day	Visual detections No	Percent	Tactual detections No	Percent	Activations No	Percent	Contact without detections or activations No	Percent	Missed No	Percent
I Low Density Grassy Area	Very fast	X	0	0	4	8	22	48	16	35	3	6
	Fast	X	1	2	0	0	15	33	10	22	19	42
	Slow	X	6	13	6	13	15	33	10	22	8	17
	Crawl	X	12	27	12	27	4	9	13	29	4	9
	Fast firing	X	10	22	2	4	14	31	9	20	10	22
	Slow firing	X	16	17	9	10	29	32	12	13	24	26
II High Density Grassy Area	Very fast	X	0	0	0	0	35	26	26	19	74	55
	Fast	X	4	3	0	0	46	34	31	23	54	40
	Slow	X	31	24	19	14	34	25	10	7	40	30
	Crawl	X	16	12	59	48	24	18	8	6	14	10
	Fast firing	X	17	10	24	13	40	22	10	6	85	47
	Slow firing	X	10	7	9	7	58	43	22	16	37	27
III Low Density Wooded Area	Very fast	X	1	2	1	2	21	47	12	27	10	22
	Fast	X	5	6	2	2	44	49	14	16	25	27
	Slow	X	12	27	10	22	13	29	5	11	5	11
	Crawl	X	11	24	18	40	11	24	1	2	4	9
	Fast firing	X	0	0	1	2	24	53	13	33	7	16
	Slow firing	X	1	2	0	0	22	49	8	18	15	33
IV High Density Wooded Area	Very fast	X	2	1	9	5	18	10	13	7	138	77
	Fast	X	10	7	0	0	19	14	22	16	83	61
	Slow	X	16	12	7	5	29	21	9	7	74	55
	Crawl	X	36	27	27	20	13	10	16	12	43	32
	Fast firing	X	7	5	1	1	30	22	12	9	85	63
	Slow firing	X	6	4	3	2	27	20	10	7	89	66

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Course	Speed	Day 2	3	4	5	6	7	Visual detections No	Percent	Tactual detections No	Percent	Activations No	Percent	Contact without detections or activations No	Percent	Missed No	Percent
I	Very fast					X		0	0	0	0	24	53	17	38	4	9
Low	Fast			X				2	4	3	7	28	52	7	16	5	11
Density	Slow				X			8	18	11	24	14	31	11	24	1	2
Grassy	Crawl	X						11	24	22	49	7	16	0	0	5	11
Area	Fast firing		X					2	3	5	7	29	41	11	16	23	33
	Slow firing						X	11	24	0	0	17	38	6	13	8	18
II	Very fast			X				0	0	0	0	43	39	32	24	62	44
High	Fast				X			5	4	0	0	52	39	27	20	52	39
Density	Slow	X						38	28	27	20	42	31	3	2	25	19
Grassy	Crawl				X			31	23	49	36	35	26	7	5	15	10
Area	Fast firing				X			8	6	5	4	53	59	33	24	36	27
	Slow firing						X	13	13	21	15	35	25	5	4	61	44
III	Very fast		X					0	0	0	0	60	75	2	3	18	22
Low	Fast			X				2	4	3	7	24	53	1	2	13	29
Density	Slow			X				1	2	2	4	34	76	4	9	4	9
Wooded	Crawl					X		8	18	13	29	11	24	5	11	8	18
Area	Fast firing	X						0	0	1	2	30	67	1	2	13	29
	Slow firing						X	1	2	4	9	26	58	3	7	11	24
IV	Very fast		X					0	0	3	2	13	10	21	16	98	73
High	Fast	X						13	8	15	9	48	30	21	13	63	39
Density	Slow				X			15	11	8	6	18	13	14	10	80	59
Wooded	Crawl					X		34	25	23	17	35	26	18	13	25	19
Area	Fast firing		X					7	5	3	2	37	27	12	9	76	56
	Slow firing	X						7	5	4	3	48	36	12	9	64	47

Figure 12. Accumulated squad data for squad B.

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Figure 13. Accumulated squad data for squad C.

Course	Speed	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Visual detections No	Percent	Tactual detections No	Percent	Activations No	Percent	Contact without detections or activations No	Percent	Missed No	Percent
I Low Density Grassy Area	Very fast		X					0	0	0	0	13	29	16	36	16	36
	Fast			X				4	9	1	2	19	42	11	24	10	22
	Slow	X						3	7	8	18	17	38	7	15	10	22
	Crawl				X			14	31	10	22	13	29	8	18	0	0
	Fast firing					X		10	22	9	20	10	22	6	13	10	22
	Slow firing						X	12	13	16	18	45	50	3	3	14	16
II High Density Grassy Area	Very fast		X					0	0	0	0	41	30	33	24	61	45
	Fast			X				8	6	4	3	40	30	38	28	45	33
	Slow				X			34	25	21	16	36	27	4	3	40	29
	Crawl	X						30	22	46	34	45	33	2	1	12	9
	Fast firing					X		36	20	18	10	59	33	14	8	53	29
	Slow firing						X	10	7	8	6	44	33	29	21	44	33
III Low Density Wooded Area	Very fast		X					0	0	0	0	25	56	5	11	15	33
	Fast	X						1	1	2	2	42	47	20	22	25	28
	Slow			X				0	0	2	4	21	47	4	9	18	40
	Crawl				X			9	20	12	27	12	27	1	2	11	24
	Fast firing					X		0	0	0	0	23	51	11	44	11	44
	Slow firing	X						1	2	3	7	19	42	7	16	15	33
IV High Density Wooded Area	Very fast		X					2	2	3	3	31	17	13	7	129	72
	Fast			X				10	7	0	0	35	27	14	10	75	56
	Slow				X			4	3	9	7	25	19	4	3	93	69
	Crawl					X		41	30	34	25	17	13	11	8	32	24
	Fast firing	X						9	7	1	1	27	20	7	5	91	67
	Slow firing	X	X					6	4	0	0	23	17	19	14	87	64

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Course	Speed	Day 2	3	4	5	6	7	Visual detections No	Percent	Tactual detections No	Percent	Activations No	Percent	Contact without detections or activations No	Percent	Missed No	Percent
I Low Density Grassy Area	Very fast	X						0	0	1	2	12	27	9	20	23	51
	Fast		X					0	0	0	0	12	27	17	38	16	36
	Slow			X				2	4	7	16	14	31	8	18	14	31
	Crawl	X						18	40	15	33	2	4	4	9	6	13
	Fast firing		X					4	4	3	3	41	46	11	12	31	34
	Slow firing					X		13	29	1	2	7	16	8	18	15	33
II High Density Grassy Area	Very fast		X					2	1	0	0	33	24	37	27	62	46
	Fast			X				3	2	0	0	44	33	34	25	49	36
	Slow	X						56	41	30	22	27	20	10	7	22	16
	Crawl			X				33	24	57	42	25	19	0	0	20	15
	Fast firing				X			8	6	7	5	49	36	22	16	49	36
	Slow firing						X	26	14	18	10	47	16	15	8	81	45
III Low Density Wooded Area	Very fast	X						0	0	0	0	44	49	21	23	25	28
	Fast		X					1	2	4	9	32	7?	3	7	5	11
	Slow			X				5	11	2	4	19	42	3	7	16	36
	Crawl			X				8	18	12	27	17	38	2	4	7	15
	Fast firing	X						1	2	3	7	22	49	2	4	17	39
	Slow firing					X		1	2	3	7	27	60	3	7	11	24
IV High Density Wooded Area	Very fast					X		7	5	0	0	13	10	15	11	100	74
	Fast		X					13	7	2	1	40	20	27	14	98	49
	Slow			X				11	8	9	7	10	7	13	10	89	66
	Crawl					X		42	31	35	26	16	12	10	7	32	24
	Fast firing			X				5	4	0	0	23	17	15	11	92	68
	Slow firing	X						13	10	0	0	20	14	9	7	93	69

Figure 14. Accumulated squad data for squad D.

Course	Speed	Day 2 3 4 5 6 7	Visual detections No	Visual detections Percent	Tactual detections No	Tactual detections Percent	Activations No	Activations Percent	Contact without detections or activations No	Contact without detections or activations Percent	Missed No	Missed Percent
I Low Density Grassy Area	Very fast	X	0	0	0	0	15	33	14	31	16	36
	Fast	X	12	27	0	0	13	29	4	9	16	36
	Slow	X	2	4	5	11	14	31	10	22	14	31
	Crawl	X	8	18	15	33	17	38	4	9	1	2
	Fast firing	X	12	27	3	7	14	31	8	18	8	18
	Slow firing	X	7	7	12	13	24	27	14	16	34	38
II High Density Grassy Area	Very fast	X	2	1	0	0	39	29	33	24	61	45
	Fast	X	26	19	12	9	55	41	5	4	37	27
	Slow	X	7	5	10	7	63	47	13	10	42	31
	Crawl	X	14	10	54	40	30	22	10	7	27	20
	Fast firing	X	15	8	8	4	45	25	16	9	96	53
	Slow firing	X	14	10	9	6	54	40	20	15	39	29
III Low Density Wooded Area	Very fast	X	1	2	1	2	19	42	4	9	20	44
	Fast	X	1	1	1	1	41	46	15	17	32	36
	Slow	X	6	13	3	7	17	38	6	13	13	29
	Crawl	X	9	20	15	33	15	33	1	2	5	11
	Fast firing	X	2	2	0	0	28	62	7	16	9	20
	Slow firing	X	0	0	1	2	25	55	9	20	10	22
IV High Density Wooded Area	Very fast	X	1	1	5	3	42	23	17	9	115	64
	Fast	X	8	6	0	0	15	11	21	16	87	64
	Slow	X	9	7	6	4	19	14	14	10	87	64
	Crawl	X	38	28	23	17	20	15	9	7	45	33
	Fast firing	X	6	4	2	1	26	19	6	4	65	70
	Slow firing	X	0	0	0	0	48	36	14	10	73	54

Figure 15. Accumulated squad data for squad E.

Course	Speed	Day (2 3 4 5 6 7)	Visual detections No	Percent	Tactual detections No	Percent	Activations No	Percent	Contact without detections or activations No	Percent	Missed No	Percent
I	Very fast	X	1	?	3	7	16	36	13	29	12	27
	Fast	X	0	0	0	0	18	40	12	27	15	33
Low Density	Slow	X	5	11	3	20	15	33	11	24	5	11
Grassy	Crawl	X	13	29	18	40	1	2	13	29	0	0
Area	Fast firing	X	2	2	7	8	34	38	9	10	37	42
	Slow firing	X	15	33	1	2	5	11	13	29	11	24
II	Very fast	X	0	0	0	0	34	25	33	24	68	50
	Fast	X	8	6	1	1	52	39	35	26	40	30
High Density	Slow	X	31	23	40	30	27	20	6	4	32	24
Grassy	Crawl	X	34	25	46	34	37	27	9	7	9	7
Area	Fast firing	X	4	3	4	3	56	41	28	21	43	32
	Slow firing	X	18	10	20	11	36	20	16	9	90	50
III	Very fast	X	0	0	0	0	56	62	24	26	10	12
	Fast	X	2	4	0	0	25	56	3	7	15	33
Low Density	Slow	X	1	2	2	4	27	60	5	11	10	22
Wooded	Crawl	X	3	7	10	22	13	29	4	9	15	33
Area	Fast firing	X	0	0	0	0	25	56	8	18	12	27
	Slow firing	X	0	0	3	7	30	67	2	4	10	22
IV	Very fast	X	2	1	0	0	39	29	33	24	61	45
	Fast	X	10	6	12	7	72	40	18	10	68	38
High Density	Slow	X	11	8	8	6	47	35	19	14	52	39
Wooded	Crawl	X	30	22	21	16	41	30	12	9	31	23
Area	Fast firing	X	9	7	0	0	33	24	14	10	80	59
	Slow firing	X	6	4	2	1	44	33	14	10	69	51

Figure 16. Accumulated squad data for squad F.

Figure 17. Accumulated squad data for squad G.

Course	Speed	Day 2 3 4 5 6 7	Visual detections No	Percent	Tactical detections No	Percent	Activations No	Percent	Contact without detections or activations No	Percent	Missed No	Percent
I Low Density Grassy Area	Very fast	X	0	0	0	0	9	20	17	38	19	42
	Fast	X	4	9	2	4	18	40	15	33	6	13
	Slow	X	6	13	5	11	10	22	11	24	13	29
	Crawl	X	5	11	14	31	19	42	4	9	3	7
	Fast firing	X	9	20	3	7	12	27	14	31	7	16
	Slow firing	X	4	4	5	6	36	40	12	13	33	37
II High Density Grassy Area	Very fast	X	0	0	0	0	29	21	41	30	65	48
	Fast	X	4	3	0	0	38	28	36	27	57	42
	Slow	X	32	24	17	13	38	2b	14	10	34	25
	Crawl	X	21	16	53	39	39	29	7	5	15	11
	Fast firing	X	10	6	11	6	103	57	5	3	41	23
	Slow firing	X	10	7	10	7	50	37	26	19	39	29
III Low Density Wooded Area	Very fast	X	0	0	0	0	33	73	5	11	7	16
	Fast	X	0	0	0	0	40	50	24	30	16	20
	Slow	X	2	4	4	9	19	42	7	16	13	29
	Crawl	X	13	29	14	31	9	20	1	2	3	7
	Fast firing	X	0	0	2	4	25	56	9	20	4	9
	Slow firing	X	0	0	1	2	22	49	6	13	16	36
IV High Density Wooded Area	Very fast	X	1	1	3	2	23	14	25	16	108	68
	Fast	X	11	8	0	0	23	17	16	12	85	63
	Slow	X	13	10	11	8	34	25	19	14	59	44
	Crawl	X	27	20	45	33	14	10	11	8	38	28
	Fast firing	X	9	7	0	0	33	24	12	9	81	60
	Slow firing	X	6	4	0	0	35	26	20	15	74	55

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Figure 18. Accumulated squad data for squad H.

Course	Speed	Day (2–7)	Visual detections No	Percent	Tactual detections No	Percent	Activations No	Percent	Contact without detections or activations No	Percent	Missed No	Percent
I Low Density Grassy Area	Very fast	X	2	4	0	0	6	13	8	18	27	60
	Fast	X	3	7	7	16	16	36	10	22	9	20
	Slow	X	5	11	8	18	20	44	5	11	7	16
	Crawl	X	17	38	17	38	4	9	3	7	4	9
	Fast firing	X	9	10	7	8	26	29	9	10	39	43
	Slow firing	X	11	24	2	4	7	16	8	18	17	38
II High Density Grassy Area	Very fast	X	4	3	0	0	37	28	34	25	61	45
	Fast	X	0	0	0	0	36	27	40	30	59	43
	Slow	X	26	19	24	18	47	35	10	7	27	20
	Crawl	X	41	30	62	46	14	10	6	4	12	9
	Fast firing	X	9	7	7	5	50	37	25	19	45	33
	Slow firing	X	27	15	16	9	35	19	22	12	80	40
III Low Density Wooded Area	Very fast	X	0	0	1	1	49	54	18	20	22	25
	Fast	X	4	9	0	0	18	40	4	9	19	42
	Slow	X	8	18	10	22	14	31	6	13	7	16
	Crawl	X	9	20	10	22	14	31	4	9	5	11
	Fast firing	X	1	2	0	0	31	69	6	13	7	16
	Slow firing	X	0	0	2	4	28	62	4	9	11	24
IV High Density Wooded Area	Very fast	X	8	6	0	0	14	10	16	12	97	72
	Fast	X	12	7	10	6	51	17	16	9	109	61
	Slow	X	17	13	8	6	16	12	12	9	79	59
	Crawl	X	61	45	23	17	14	10	7	5	26	19
	Fast firing	X	8	6	1	1	24	18	9	7	93	69
	Slow firing	X	11	8	2	1	20	15	11	8	91	67

Course	Speed	Visual detections	Tactual detections	Activations	Contact without detections or activations	Missed
I Low Density Grassy Area	Very fast	0.75	2.12	32.27	30.62	33.37
	Fast	7.25	3.62	38.62	23.87	26.62
	Slow	10.1	16.37	32.87	20.00	19.87
	Crawl	27.25	34.12	18.62	13.75	6.37
	Fast firing	13.75	8.00	33.12	16.25	28.75
	Slow firing	18.8	-6.87	28.75	5.37	28.75
II High Density Grassy Area	Very fast	0.74	0.00	26.94	24.90	47.50
	Fast	5.37	1.62	33.87	22.87	36.25
	Slow	26.6	17.5	29.12	66.25	24.25
	Crawl	20.25	39.87	23.00	4.37	11.31
	Fast firing	9.28	6.66	36.11	12.14	35.55
	Slow firing	10.37	8.87	29.12	13.00	37.62
III Low Density Wooded Area	Very fast	0.5	0.63	57.25	16.25	25.25
	Fast	3.37	2.62	51.5	13.75	28.25
	Slow	9.62	9.5	45.12	11.12	24.00
	Crawl	19.44	28.33	28.33	5.27	16.11
	Fast firing	0.83	1.94	57.77	15.83	22.22
	Slow firing	1.00	4.75	55.25	11.75	27.25
IV Low Density Wooded Area	Very fast	2.12	1.75	15.37	12.75	68.12
	Fast	7.00	2.87	22.00	12.5	53.87
	Slow	9.00	6.12	18.25	9.62	56.87
	Crawl	28.5	21.37	15.75	8.62	25.25
	Fast firing	5.62	0.75	21.37	8.00	64.00
	Slow firing	4.87	0.87	24.62	10.00	59.10

Figure 19. Squads accumulative total percent.

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(b) The most frequently occurring number of activations per individual in a run was three. This occurred seven times.

(c) During every run, some soldiers made contact with tripwires and neither detected the tripwire nor detonated the mine simulator. The most often cause of no detonation was that the tripwire had broken. This usually occurred when the tripwire became entangled in two clumps of grass and was then pulled at some point between the entanglements. The highest percentage of squad contacts without detection or activation was 44 percent. The lowest percentage was one percent. Details are found in figures 10 through 20.

c. Objective 3 was to investigate the time delay results of a tripwire minefield. The findings for this objective are shown by subobjective.

(1) Subobjective 3.1.

(a) Baseline times of delay range from a high of 1 minute 43 seconds to a low of 55 seconds.

(b) Baseline delay times are defined as the controlled condition at slow speed.

(2) Subobjective 3.2.

(a) Squads experienced delays from tripwire minefields under all combinations of terrain, mine density, soldier speed, and soldier action which were tested (fig 21).

(b) The greatest percentage of delay, 138 percent, occurred in course I (low density, grassy area); the smallest percentage of delay, 65 percent, occurred in course II (high density, grassy area).

d. General findings.

(1) Seventy-two soldiers, organized into eight squads, were exposed to a total of 18,810 tripwires.

(2) Tripwires broke with greater frequencies than had been anticipated. A replacement shipment did not arrive before completion of the test; therefore, 8-pound monofilament fishline was used as a substitute for the standard tripwire. This substitution occurred only on day 6 of the test on courses I and II and involved 150 fishline exposures. This was approximately one percent of all exposures during the test. The percentage of detections was 59 percent as compared to a detection rate of approximately 20 percent for the standard tripwire. Because of the small number of iterations involved and the subsequent negligible impact on calculation, these data were not removed from the test data tables.

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Subobjectives: 2.1 Proportion of soldiers in a squad who activated one or more tripwire mines in their lanes under the listed conditions.

2.2 Average number of tripwire mines activated by soldiers in a minefield across their path under each of the listed conditions.

Course	Speed	Number who activated one or more tripwires	Proportion (subobj 2.1)	Total number of tripwires activated	Average number of tripwires activated by each activator	Average number of tripwires activated by each squad member (subobj 2.2)
I Grassy Low Density	Very fast	55	0.76	117	2.13	1.63
	Fast	58	0.81	139	2.40	1.93
	Slow	61	0.85	119	1.95	1.65
	Crawl	46	0.64	67	1.46	0.93
	Fast firing	57	0.79	180	3.16	2.50
	Slow firing	54	0.75	201	3.72	2.79
II Grassy High Density	Very fast	71	0.99	291	4.10	4.04
	Fast	72	1.00	363	5.04	5.04
	Slow	68	0.94	314	4.62	4.36
	Crawl	67	0.93	249	3.72	3.46
	Fast firing	70	0.97	500	7.14	6.94
	Slow firing	67	0.93	359	5.36	4.99
III Wooded Low Density	Very fast	67	0.93	307	4.58	4.26
	Fast	69	0.96	266	3.86	3.69
	Slow	64	0.89	164	2.56	2.28
	Crawl	55	0.76	102	1.85	1.42
	Fast firing	72	1.00	208	2.89	2.89
	Slow firing	68	0.94	199	2.93	2.76

NOTE: Number of soldiers is 72 for all conditions.

Figure 20. Mine activation summary.

Course	Speed	Number who activated one or more tripwires	Proportion (subobj 2.1)	Total number of tripwires activated	Average number of tripwires activated by each activator	Average number of tripwires activated by each squad member (subobj 2.2)
IV Wooded High Density	Very fast	51	0.71	193	3.76	2.68
	Fast	61	0.85	283	4.64	3.93
	Slow	58	0.81	198	3.41	2.75
	Crawl	63	0.88	170	2.70	2.36
	Fast firing	64	0.89	233	3.64	3.24
	Slow firing	63	0.88	265	4.21	3.68

NOTE: Number of soldiers is 72 for all conditions.

Figure 20 (cont). Mine activation summary.

Subobjectives: 3.1 The average amount of time taken by a squad to traverse a premeasured lane.
3.2 The times taken by an average squad are compared to the average baseline time.

Course	Speed	Average baseline time[a] (subobjective 3.1)	Average squad traverse time (subobjective 3.1)	Difference (subobjective 3.2)	Percent of deviation from baseline time
I	Very fast		0:34	-1:07	- 65
	Fast		1:08	-0:35	- 35
	Slow[b] – – – – 1:43	4:05	+2:22	+138
	Crawl		4:39	+3:56	+229
	Fast firing		1:25	-0:16	- 16
	Slow firing		1:57	+0:14	- 14
II	Very fast		0:26	-0:52	- 66
	Fast		1:01	-0:17	- 21
	Slow[b] – – – – 1:18	2:09	+0:51	+ 65
	Crawl		12:52	+11:34	+890
	Fast firing		1:26	+0:08	+ 10
	Slow firing		2:19	+1:01	+ 78
III	Very fast		0:29	-0:30	- 51
	Fast		0:56	-0:03	- 5
	Slow[b] – – – :59	2:10	+1:11	+120
	Crawl		6:29	+5:30	+559
	Fast firing		1:06	+0:07	+ 12
	Slow firing		1:15	+0:16	+ 27
IV	Very fast		0:28	-0:27	- 49
	Fast		1:08	+0:13	+ 24
	Slow[b] – – – :55	2:03	+1:16	+120
	Crawl		8:52	+7:57	+867
	Fast firing		1:08	+0:13	+ 24
	Slow firing		1:38	+0:43	+ 78

[a]Baseline time was without interference of mines
[b]Baseline speed corresponds to the slow speed

Figure 21. Time delay summary.

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(3) Some of the more effective countermeasures which were noted during the test were:

(a) High stepping. The individual proceeded through the minefield lifting his feet approximately twenty-four inches off the ground.

(b) Rolling shirt sleeves up. By performing a tactile search with the sleeves rolled up and cradling his weapon, the individual was more successful in finding the tripwires than was an individual who conducted his search with his sleeves rolled down and placing his weapon upon the ground after each advancement of his position.

GLOSSARY OF TERMS

The terms listed below are defined to assist the reader in understanding the test data.

    a. Condition. The speed at which soldiers traversed the lanes and the firing or nonfiring action of the soldier.

    (1) Nonfiring actions.

    (a) Very fast speed. A run, approximately 180 steps per minute.

    (b) Fast speed. Approximately 120 steps per minute.

    (c) Slow speed. Approximately 80 steps per minute.

    (d) Crawl. Moving slowly with the body close to the ground.

    (2) Firing actions.

    (a) Fast speed firing. Firing two magazines of blank ammunition per man while moving 120 steps per minute.

    (b) Slow speed firing. Firing two magazines of blank ammunition per man while moving 80 steps per minute.

    b. Day. The cross (X) indicates when a particular run was conducted (fig 11 through 18). A run is defined as a squad going through a particular course under one condition.

    c. Visual detections. The total number of tripwires which were detected visually by all members of a squad during a run (fig 11 through 19). The percent of tripwires actually present which was visually detected by the squad.

    d. Tactual detections. The number and percentage of tripwires that were detected by feeling the wire without a resulting activation (fig 11 through 19). The tripwires had not been detected visually. This includes tactile detections made by feeling with the arms and hands (primarily during the crawl) and the feet and legs. It should be noted that during this test, credit was given for tactual detections (without activations); it must be considered that these detections could have resulted in activations of the actual mine since there is a difference in the pull force necessary to activate either of the mines (i.e., four-tenths of a pound for the actual mine and five-tenths of a pound for the simulated mine).

e. Activations. The number and percentage of tripwires that were tripped and caused activation of the mine simulators (fig 11 through 20).

f. Contact without detection or activation. The number and percentage of tripwires that were contacted, but were neither detected nor caused the activation of the mine simulator (fig 11 through 19). The numbers in the contact without detection or activation column include both the wires which were pulled and broken and the wires which were pulled and not broken. It is likely that with the actual trip-wire mines the numbers in this column could all be considered activations.

g. Missed. The number and percentage of tripwires which were not contacted or detected (stepped over or around) as a soldier moved through a lane during a run (fig 11 through 19). The sum of the "missed" column, the visual detections column, and the tactual detections column gives the total number of tripwires which the soldiers in the squad successfully avoided. The sum of the activations column and the contact without detection or activation column gives the total number of tripwires the soldiers in the squad contacted and could be considered to have caused activations, assuming 100 percent reliability of the tripwires and mines.